DOCUMENT RESUME

ED 154 452 CS 502 099

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TITLE Not Whether You Win or Lose-It's How You Play the Game Theory.
PUB DATE Apr 78
NOTE 15p.; Paper presented at the Annual Meeting of the International Communication Association (Chicago, Illinois, April 25-29, 1978)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Cognitive Processes; *Communication (Thought Transfer); Concept Formation; *Conflict; *Decision Making; Decision Making Skills; *Game Theory; *Logical Thinking; Probability; *Problem Solving; Theories

ABSTRACT

The development of game theory was a response to a need to understand human decision making processes in situations of incomplete or imperfect information. By reducing decision making situations to probability game systems, it is possible to analyze and test various competitive strategies that maximize wins and minimize losses. Although game theory assumes rational situations faced by rational individuals, it is possible to apply it to situations in which available strategies are not used through application of the Augustinian interpretation which states that nonrational lack of information of a team is simply an additional variable adding to the positive score of the opponent. It can also be applied to situations in which all available strategies are not known, through applying the subjective rationality concept which assumes behavior is rational given the perceptual and evaluational premises of the subject. Therefore, in spite of sharp criticism of its limitations, game theory remains a strong tool in field situations for the analysis, if not the prediction, of decision making processes. (MAI)

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Not Whether You Win or Lose - It's How You Play the Game Theory

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Not Whether You Win or Lose - Its How you Play

the Game Theory

Three decades ago a behavioral-mathematical series of complex formulae and constructs labeled "Game Theory" was introduced and employed to solve some unique probability questions connected with the development of atomic reactors (McCracken, 1955).[1] When subsequently applied to human behavior, the Game Theory model originally proposed by Von Neumann suggested a structure for understanding a variety of interpersonal situations involving trust, bargaining, and decision making (Von Neumann and Morganstern, 1947).[2] The model has since been widely employed in political science (Schelling, 1960),[3] in economics (Shubik, 1959),[4] and (often through the "prisoners' dilemma" paradigm) in communications (Swansson, 1967).[5] Like all fads and a few important truths, however, game theory is no longer "in". It is rarely mentioned in basic communication theory texts; it has largely been replaced by the more methodologically intriguing Markovian Chain Model in studies of coalition formation; and it has faded from popularity in the allied fields of statistics, political science, and psychology (Nemeth, 1972).[6]

The purpose of this paper is not to mourn a passing theory, once useful and exciting but not apparently condemned to dusty library corners. Rather, it is to suggest that we may have buried game theory prematurely, dismissing it before exhausting a wide range of interesting applications. Of course, Von Neumann's theory was not simply tossed aside like a no longer shiny toy. To suggest so would be a serious error. Game theory is no longer a popular construct because it no longer seems to be useful in understanding reality.

Originally game theory was thought to have great predictive value. Economists and governmental advisors attempted to use the game formulae to discover the "best" or most successful policy options. There is some evidence that the Kennedy Administration tried to use game theory analysis during the Cuban Missile Crisis (Kennedy, 1971).[7] Unfortunately, a simple flaw or limitation of the theory quickly became apparent. Game theory begins with the assumption of a situation in which all "players" are rational (Nemeth, 1972).[8] Reality apparently violates that assumption on frequent occasions.

Since the term "rationality" has a number of diverse meanings in different disciplines, a simple definition may prove useful here. Rationality has two component parts: logic (the process of making decisions according to internally valid principles) and knowledge (the foundation of decisions on externally verifiable facts and information). To make a rational decision, one must employ a logical process in evaluating known data. According to this rather esoteric definitional scheme, the opposite of rationality would be a philosophy of randomization, in which it is not possible to predict a decision since that choice is not based upon information nor conducted through logical processes.

The development of Game Theory was a response to a need to understand human decision making processes in situations of incomplete or imperfect information. Morgenstern (1949)[9] described the requirements of the theory as:

> "Such a theory must be quantitative, which means that it must ultimately assume a mathematical character. A theory of games fulfilling these requirements would take into account that participants in a game vary in information and intelligence, that they have various expectations about the other players' behavior, and that different paths of reaching their goal may be open to them. The theory must also allow for the fact that the position of a player...is often adversely affected if his opponent finds out his intentions."

As finally formulated, game theory is highly complex but the basics are quite simple. By reducing decision making situations to probability game systems, it is possible to analyze and test various competitive strategies. Although certain specific circumstances require minor variations, the theory can mathematically be stated in the general form:

$$U = \phi (x, y, \ldots)$$

in which U represents the final entity of value (outcome) of the game; ϕ is defined as the function or process involved in the game; and x, y,.. represent the variables of the function (players' strategies). (Von Neumann, 1944).[10] That is, the outcome of any competitive game is a function of that game process as it is played by the individual participants. The specific function can be inserted in the formula as a description of the probabilities and moves involved in the game. When the propensities of preferences of the players (x, y, etc.) are inserted (again, in the form of probability values) the complete formula will presumably evaluate the success of various strategies in any game situation.

Though game theory will never predict a specific outcome with certainty it will suggest the most successful strategy for maximizing wins while minimizing losses over a series of trials (Rapoport, 1962.)[11] Wiener (1954)[12] explains the problem in terms of maximized intention: "Literally speaking, the game theory of Von Neumann,....concerns one team which will resort to any strategy to jam the message." However, if one party does not act deliberately, and rather follows a haphazard system of play; or if the other team loses interest and no longer bothers to find the most successful jamming strategy, the formulae of game theory will no longer be useful. Only when both parties are dedicated

to winning in the most efficient manner can game theory prove useful.

A quick blance at the birth of game theory will reveal the reason behind the rationality assumption. As previously mentioned, Von Neumann's theory was first applied to problems of physics. Apparently neutrons always react in a highly predictable (or "rational") manner. Later expansions of the theory to economics were based upon clearcut situations in which profit was clearly desired and loss was clearly feared. But can you imagine playing the "prisoner's dilemma game against an opponent who finds confinement a subject of random indifference? Certainly such nonrational approaches will render the model useless.

Despite attempts at assuring rationality by employing high win-loss reward systems and increasing sample size to balance deviant behaviors, communication scholars have increasingly lost interest in game theory. While useful in the laboratory, games prove of very limited value in the field. In "real life" situations players are not always rational, or lack the necessary information to behave rationally. After all, if one team cannot determine the maximally effective method of "deliberately trying to get a message across", or if the other team members forget the most efficient strategy of "jam the message", the predictions of the game theory will not be born out.

However, it is possible to overcome the problem of nonrationality caused by whim or ignorance, and hence increase the usefulness of game theory. Surprisingly, the key is theological, and can be found in one of the earliest theories of ancient Christianity.

There was an early schism in the Christian church between competing philosophies of Augustinians and Manichaeans (Ling, 1968).[13]

Augustinian position, based upon earlier platonic philosophies, described unity of good and evil in which the Devil was defined as the absence

of God. In terms of modern game theory, goodness was seen as a zero-sum situation: as one moved away from God, one was increasingly moving toward evil. Manichaeism argued that a duality existed between good and evil; that the devil was a separate entity and that evil was "an independent principle" (Battenhouse, 1956).[14] Under the Manichaen schema one could be close to God and still be lured or attacked by the Devil (a non-zero sum situation). Norbert Wiener[15] related the Manichaen-Augustinian controversy of antiquity to modern gaming: "The Manichaen Devil is an opponent, like any other opponent, who is determined on victory and will use any trick of craftiness or dissumulation to obtain his victory. In particular, he will keep his policy of confusion secret and if we show any sign of beginning to discover his policy, he will change it in order to keep us in the dark.

"On the other hand, the Augustinian Devil, which is not a power in itself, but the measure of our own weakness, may require our full resources to uncover, but when we have uncovered it, we have in a sense exorcised it ..." Wiener suggested that the criticism of Game Theory based upon Incomplete knowledge was founded in the concept of a Manichean opponent. On the contrary, Weiner argued, the principles of game theory, which he subsequently applied to the new science of cybernetics, are equally valid under an Augustinian interpretation.

If one views competition and gaming through Augustinian-colored glasses, non-rational lack of information of one team is simply an additional knowledge of the other. One deals not necessarily with two all knowing powers (a Devil and a God) but rather with two devil-gods, each containing seeds of its own victory and defeat. Those negative elements eventually work to the betterment of the opponent. Ignorance, then can be measured and described as an additional variable adding to the positive score of an opponent. Every strategy I do not consider in effect adds an additional winning strategy to your situation.

In the Civil War Battle of Antietam, for example, Burside's insistence upon taking the bridge when the stream was easily fordable elsewhere gave a distinct advantage to the Confederate forces defending the bank. The nonrational (based upon missing information) strategy of the Union troops does not weaken the applicability of game theory. By calculating "nonfording" and a winning Confederate strategy, the game calculations will accurately predict a winner, and the price that a victor must pay.

Perhaps the point is most clearly explained in terms of the game theory concepts of "zero sum" and "non-zero sum" games. In a zero sum game, the scores of the two players, not surprisingly, sum to zero. For example, the amount of yardage gained by football team A and the amount of turf lost by team B will always balance at zero. In a non-zero sum game, the scores are independent of each other. If downhill ski racer Q shaves a quarter of a second off of his time in the slalom, that fact does not automatically add a quarter of a second to the times of all opponents.

The battle of Antietam is clearly a zero sum situation. A loss for the Union is a proportionate gain for the Confederacy. While Burnside's failure to observe or utilize alternate strategies does not actually increase the number of strategies available to his opponents, it does proportionately strengthen their strategic position. In direct competition games, then, ignorance or forgetfulness on the part of one player serves as a positive weapon for the other. In non-zero sum games, of course, the reduction of option A from the first player will not directly help the second player, but will increase his relative strength of position. Hence, if Billy Kid forgot his ski poles it would not increase the speed of Jean Claude Killy, but one would feel confident wagering a large sum on the likelihood of Killy's relative victory.

Despite the apparent limitation of game theory to situations in which participants are all knowing, game theory can be useful in field situations of limited information. Of course, a crucial problem still exists. We may be able to apply game theory to the analysis of a battle fought a hundred years ago, but can we utilize the model to solve contemporary problems? No doubt there are situations in which the experimenter, as well as one or more of the players, is unaware of or unable to calculate a possible option. In these cases of limited knowledge, is it still practical to rely upon game theory?

In 1957 Herbert Simon introduced the concept of "subjective rationality." In conventional criticisms of game theory, an objective conceptualization of rational action is utilized, defined as "behavior that is rational as viewed by the experimenter." Game Theory is equally applicable, however, if one works from the assumption of subjective rationality: "behavior that is rational, given the perceptual and evaluational premises of the subject" Simon, 1957.[15] By viewing the situation from the perspective of the players, it is possible to apply the model to situations which once apparently violated the rationality assumption. With this insight, the value of game theory is greatly expanded.

It is now possible to apply the mathematical formulae of game theory to situations in which one party "forgets" or "ignores" an obvious option, calculating the strategic loss for one participant as a strategic gain for the other. And, in situations in which some options or influences are unknown to participants and experimenters, one can deal with subjective operationalization of reality, considering only the options perceived by the player as available. Using a subjective view of rationality, the modified game theory formula will still accurately (probabilistically) analyze the best decision available.

The revised formula states:

$$U = \phi\ (x,\ 1\text{-}x\ldots)$$

The result of a specific game (U) is dependent upon the function ϕ (process of moves) and the individual strategies of the players expressed in terms of relative probabilities of dependent strategies (x, x-1, ...) rather than as absolute probabilities of independent strategies. The revision is minor, but the effect is significant. With this small modification, the application of game theory can be greatly expanded to nonrational situations.

We can conceive, of course, of a situation in which the best decision available is still not a necessarily wise move. And, of course, a more worthwhile strategy (unknown to the participants) may theoretically be available. But through the addition of the concepts of Augustinian competition and subjective reality, we can greatly expand the usefulness of game theory to include the prediction of results and selection of "best" available strategy even in situations of incomplete knowledge and non-recognition of an available alternative.

It is still possible that one or more of the players in a game will react nonrationally (randomly). In such a situation, where the nonrational action is not based upon either a lack of information nor a subconscious rejection of information, game theory will not be useful. If the player has forgotten how unpleasant confinement may be, or is not aware of the discomforts involved, we may still utilize game theory to predict his behavior in a prisoner's dilemma game. If he is simply indifferent and acts capriciously, however, we have no option but to search for an alternative theory. Gaming will deal with "normal" people: with people who behave in ways approaching the societal norms. Deviants, definitionally, will react unpredictably. In such a situation, game theory still must be dismissed, for even though knowledge may be complete the other assumption of rationality that of logic, is violated. Wiener's point clarifies the informational

aspect of rationality. The deviant, however, is not logical even if all knowing. The game theory formula, therefore, is not of value.

Of course, in a relatively large sample there are not likely to be many deviant members. After all, a large number of deviants will influence a change in the norm, and hence not be deviants at all. The minority of individuals to which game theory can not be applied can, therefore, be dealt with statistically in much the same way that idiosyncracies tend to cancel each other out of a large sample.

The erosion of interest in game theory can mainly be attributed to the limitations of its usefulness. Game theory serves as an accurate tool of human competitive behavior only in rational situations faced by rational individuals. Through a re-examination of the rationality assumption, however, it has been demonstrated that the situational limitation is not real. Since game theory can be applied to situations in which available strategies are not utilized (through the Augustinian interpretation) and to situations in which all available strategies are not known (through the subjective rationality concept), it is possible to apply game theory formulae to all conceivable competitive situations. One simply calculates ignored strategies as positive strategies for the opposition (in the first case); or calculates perceived strategies for the opposition (in the second case). In both situations, Weiner, Rapoport, Morganstern, and Von Neumann have shown that the mathematical calculations prove reliable with these assumptional adjustments.

One could choose an illustration of the modified formula from any area of communications in which participants are in some sort of conflict or competition. Such confrontation is most dramatically apparent in the field of debate, and the recent 1976 Presidential Debates[15] will provide clear and timely examples. One could easily employ the inrevised game theory model to analyze the Carter-Ford debate of October 6, 1976 concerning future directions for American foreign policy (CBS, 1976). Examining two of the question-series of that debate will

quickly demonstrate the limitation of that original model and the advantage of the minor modifications suggested.

Approximately two-thirds through the 90-minute confrontation, President Ford was asked a question concerning the status of Eastern European countries. His responsive statement to the effect that Yugoslavia, Poland, and the other Eastern European nations are not controlled by the Soviet Union became a major campaign issue in the subsequent campaign. If we are to accept President Ford's later retraction, that statement was a slip of the tongue. In the terminology of game theory, Ford adapted a strategy which was not rational, for it followed a non-logical pattern. (Governor Carter, in reply, clearly disagreed with Ford's statement, and suggested that Ford was not in touch with the real situation.) If we attempt to apply the original formula to that situation, we find that:

Outcome of the exchange = (process of the game) (strategy of Ford) (Carter). Theoretically, since Ford's strategy was in violation of the assumption of the model, that equation cannot be analyzed. Mathematically, one might argue that Ford had no (or "zero") strategy in that situation, producing no outcome of the exchange. Clearly, however, there was an outcome, and that outcome was of serious consequence to the Ford campaign. At best, then, the formula is unworkable; at worst, it produces an inaccurate result.

The revised theory produces a much more satisfying result. The same exchange analyzed shows that:

$$\text{(Outcome of the exchange)} = \text{(process)} \frac{\text{(Ford's strategy)}}{\text{1-Ford's strategy}}$$

The assumption is no longer necessary for the analysis. Since Carter's strategy is represented here by the inverse of Ford's strategy, clearly the zero previously assigned to Ford gives Carter a clean edge (1) in the confrontation. Of course, if Carter had agreed with Ford's blunder, we would assign to Ford a score of (1-Carter), and the outcome would have been a tie. In this case, then, the revised game theory formula is clearly superior to the original as a repre-

sentation of reality.

Later that same evening, Carter answered a question regarding disengagement in Europe and showed a clear lack of knowledge about the situation. Ford subsequently corrected Carter's error. The same procedure applied above again demonstrates the value of the modification in the game theory formula. By viewing the two "players" strategies in relative dependent terms, we avoid the need for perfect information and can analyze the situation in the real circumstances of lack of knowledge.

Of course, we are still left with a significant limitation upon the usefulness of game theory. In some situations, it may be possible to determine the subjective reality (and hence subjective rationality) of a player. Observing behaviors in a continuing small group may provide perceptual cues that will allow accurate analysis of future actions even though those decisions will be based upon incomplete or imperfect knowledge. In many cases, however, only a post hoc analysis will reveal the subjective rationality of the player, thus limiting the immediate analytical value of the game theory model.

In many fields a model limited to analytical rather than predictive application is an extreme handicap. A great deal of economics and political science, for example, is based upon predicting what will happen rather than explaining what did take place. In communications, however, the usefulness of an analytical model is not so severely limited. While we are indeed interested in knowing what will happen, we are at the research stage in which we are, and ought to be, interested in why a speech was persuasive, an organizational approach was unsuccessful, a group developed cohesiveness, or an oral style was effective. Finding the "why" will lead us to the "what next?" stage of inquiry. Game theory can help us understand why certain communication acts had observed effects in competitive situations. The value of such a tool should not be discounted. Game theory was rightfully dismissed as a predictive model, but ought rightfully to be revived as a model of analytical value in

communications.

The prisoner's dilemma became popular as a laboratory tool because it met the supposed rationality assumptions of game theory. It has since been overused, misinterpreted, and largely degraded as non-predictive (Nemeth, 1972)[16] in field situations. With this re-examination of game theory, however, it is no longer necessary to throw the baby out with the bathwater, or the theory out ( ) the paradigm. Game theory can continue to be utilized as a strong tool in field situations for the analysis, if not the prediction, of decision making processes.

BIBLIOGRAPHY

Roy W. Battenhouse, Companion to the Study of St. Augustine (New York: Oxford University Press) 1956.

Columbia Broadcasting System, "Presidential Debates," 9:30 p.m. EDT, October 6, 1976.

Trevor Ling, History of Religion: East and West (Harper & Row, New York) 1968.

Robert F. Kennedy, Thirteen Days: A Memoir of the Cuban Missile Crisis (New York: W. W. Norton & Company, Inc.) 197.

Daniel D. McCracken, "The Monte Carlo Method", in David M. Messick, Mathematical Thinking in Behavioral Sciences (San Francisco: W. H. Freeman) 1968 (reprint from Scientific American, May 1955).

Charles Nemeth, "A Critical Analysis of Research Utilizing the Prisoner's Dilemma Paradigm for the Study of Bargaining," In Advances of Social Psychology (Volume 6) edited by Leonard Berkowitz (New York: Academic Press) 1972.

Anatol Rapoport, "The Use and Misuse of Game Theory", in David M. Messick, Mathematical Thinking in Behavioral Science (San Francisco: W. H. Freeman 1968 (reprint from Scientific American, Dec. 1962.)

Thomas C. Schelling, The Strategy of Conflict (Cambridge: Harvard University Press) 1960.

Martin Shubik, Strategy and Market Structure: Competition Ologolpoly and the Theory of Games (John Wiley and Sons) 1959.

Herbert A. Simon, Models of Man (New York: John Wiley & Sons, Inc.) 1957.

R. B. Swansson, "Cooperation in the Prisoner's Dilemma Game." Behavioral Science, 1967.

John Von Neumann and Oskar Morgenstern, The Theory of Games and Economic Behavior. (Princeton, N. J.: Princeton University Press) 1944.

Norbert Wiener, The Human Use of Human Beings. (Garden City, N.Y.: Doubleday) 1954.